The Machine Part Tool in SKF @ptitude Observer 9

Introduction

The machine part tool in SKF @ptitude Observer is an important part of the setup. By defining the machine parts, it is possible to make a sophisticated vibration analysis of the collected measurement data.

In the machine part tool all the components of the machine drive line are defined. Using the machine part tool, the user creates a model of the machine. In this model, the shafts, bearings, gear boxes, drive belts, engines, blades, generators along with other machine parts are connected to the drive line. **Fig. 1** shows the driveline for a belt driven fan.

Based on the mechanical data for the machine, the machine part tool calculates the fault frequencies for parts like roller bearings, gears, fan wheels and shafts. The bearing library in SKF @ptitude Observer has geometrical data from approximately 20 000 bearings from SKF and a number of other vendors.

Using the information the user entered, in combination with the information in the databases, allows for a calculation of the specific vibration frequencies of the machine components, see **figs. 2a** and **2b**.
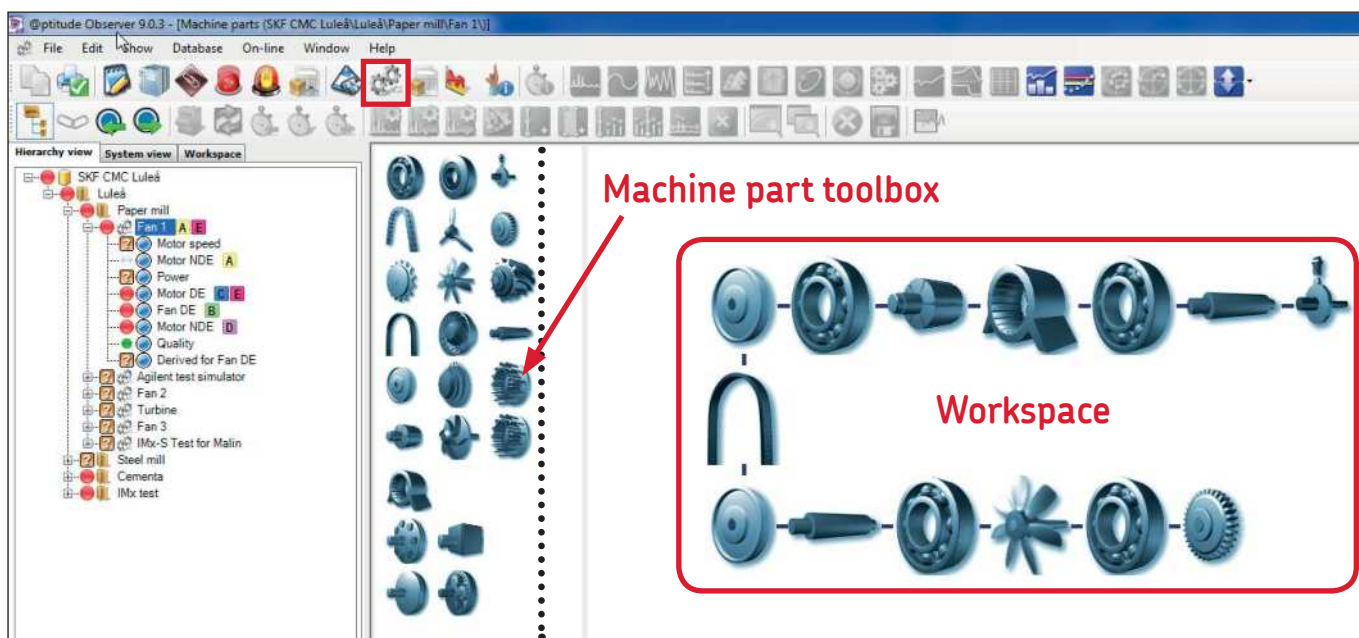

Fig. 1. The machine part tool window in SKF @ptitude Observer showing the drive line for a belt driven fan.

The vibration spectrum in **fig. 2a** shows the fault frequencies for the bearing "Generator NDE". A close up of the vibration spectrum is shown in **fig. 2b**. The first "red line" from the left is the Fundamental Train Frequency (FTF), i.e., "cage frequency", followed by the Ball Spin Frequency (BSF), Ball Pass Frequency Outer race (BPFO) and the Ball Pass Frequency Inner race (BPFI). Only two of the displayed fault frequencies hit the vibration peaks – the "Generator shaft" and the "Outer race" frequency for the "Generator bearing".
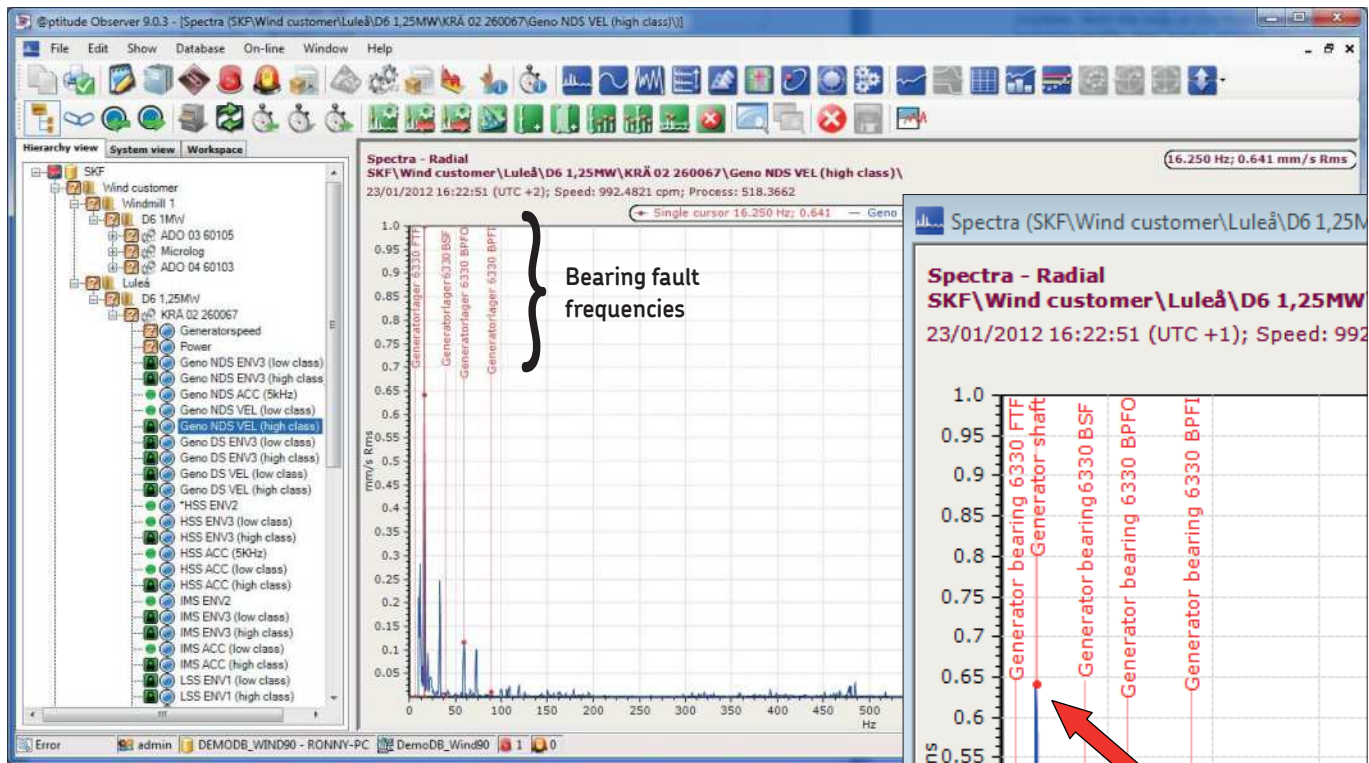

Fig. 2a. The fault frequencies (in red) for the "Generator NDE" are displayed.
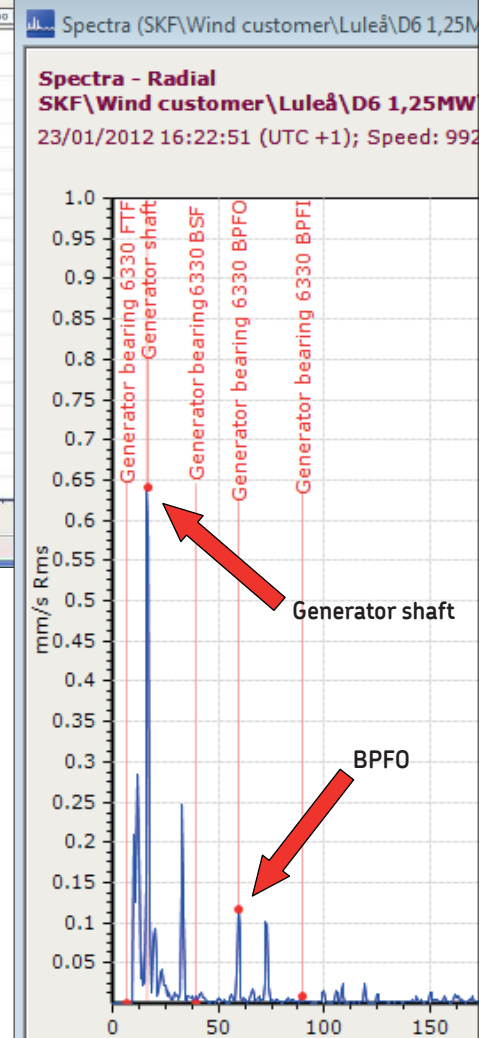
NOTE: The SKF Online Repository (SKF OR) is an information repository shared and created by SKF @ptitude Observer users around the world. As new knowledge and information is available, the system can automatically download and make use of the information provided in the SKF OR. You can choose to take part in the community more actively by sharing your knowledge and experience to the world.

Information about the **SKF online repository** can be found at the end of this application note.

Fig. 2b. A close up of the vibration spectra in fig. 2a.

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Procedure

Creating the drive line

Select a machine to work on in the hierarchy tree in **fig. 3**. In this case "Fan 2" was selected. Then click on the "machine part tool" icon in the main menu. A close up of the icon is shown in **fig. 4a**. The "Machine parts" are also available when right-clicking on a machine in the hierarchy tree (→ **fig. 3**). **Fig. 4b** shows a close up of the icon that includes the information about the "rotational speed" of the driving shaft. This shaft is normally the shaft of the electrical motor. Right-click on this icon and then select "Properties", the window in **fig. 4c** will be opened. Then click the button with the three "dots" to add the measurement point for the rotational speed. The window in **fig. 4d** will be opened. Select the "speed" measurement point from the hierarchy tree and then click the **OK** button.
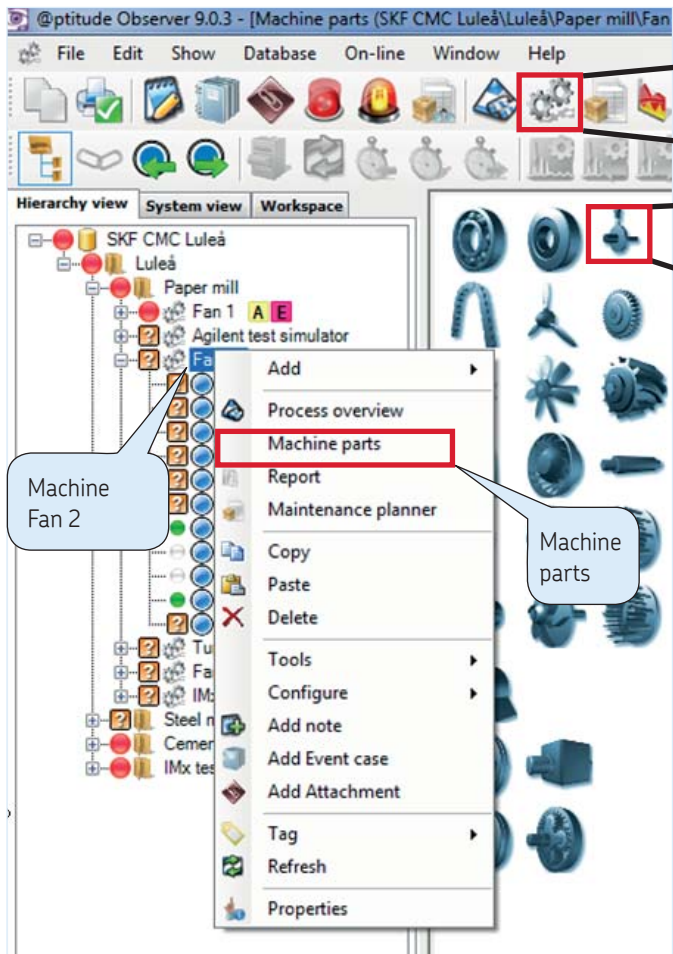

Fig. 4a. The machine part tool icon.

Fig. 4b. A close up of the machine part icon, which includes the information of the rotational speed of the shaft.
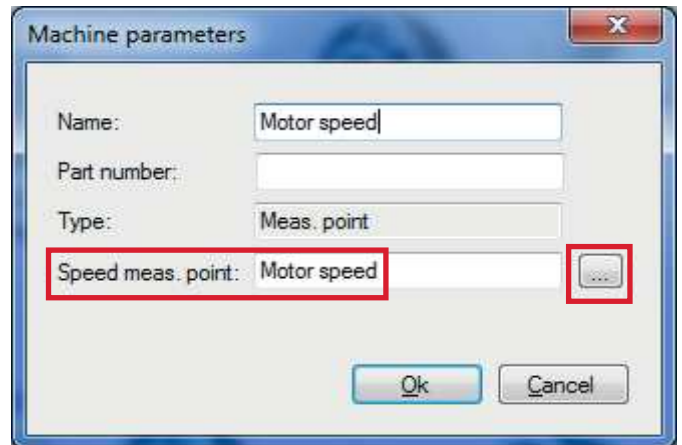

Fig. 3. The machine part window can also be opened from a machine in the hierarchy tree.

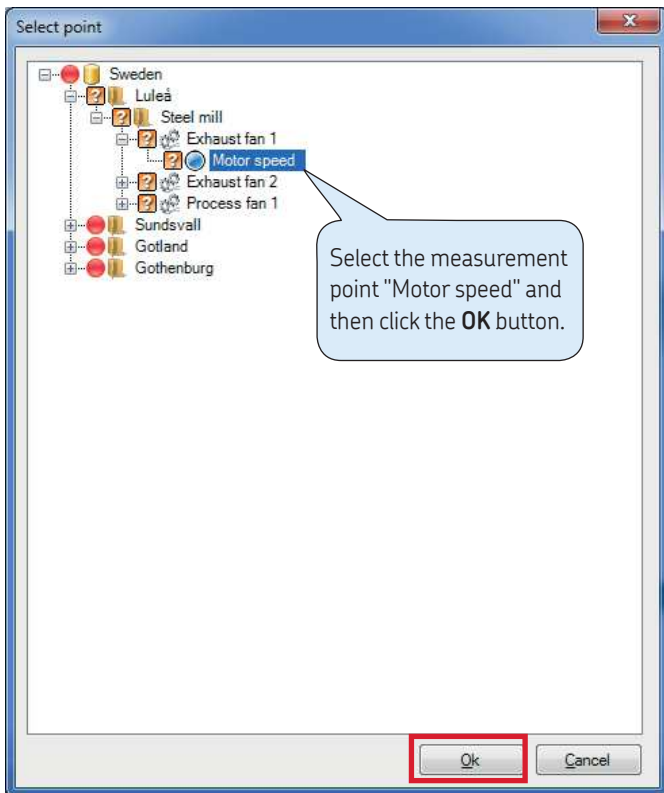*Fig. 4c. Adding a rotational speed point from the hierarchy tree.*

Fig. 4d. Add the measurement point "Motor speed", which is the rotational speed of the motor shaft.

Continue to drag and drop the desired machine parts from the "Machine parts" toolbox window to the workspace on the right (→ **fig. 7**).

NOTE: It is important that the first machine part is a shaft, which the remaining parts are connected to.

Dragging and dropping machine parts close to each other will automatically create a **black** link between them (→ **fig. 7**). To link one gear wheel to another gear wheel, simply drag and drop the gear wheel close to the other wheel.

NOTE: The machine parts are only connected with each other if they have a "**black link**" between them. Without a black link, the machine parts are not connected and the gear ratio for the drive line and the fault frequencies for the machine parts cannot be calculated.

To link the model to the preselected machine, drag the rotational speed icon **in fig. 4b** from the "Machine Parts" toolbox and drop it on the end of the driving shaft. By connecting the rotational speed to the driving shaft, the fault frequencies for connected components like bearings, gears and other parts are calculated.

NOTE: When the machine fault frequencies are calculated, it is possible to link the diagnosis rules to the model to optimize and speed up the vibration analysis work.

See application notes:
- CM3218 **Machine Diagnostic in SKF @ptitude Observer 9 – Private Rules**
- CM3203 **Machine Diagnostic in SKF @ptitude Observer 9 – Standard Rules**

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Machine parts can be copied from an existing machine.

NOTE: The copied machine parts will overwrite the existing machine parts on the machine you copy to.

Open a "Machine part" window for the new machine, in this case called "Fan 2" (→ **fig. 5**). Then right-click in the "Machine parts" window and select "**Copy from existing machine**" from the pop-up menu. The **Select machine** window opens (→ **fig. 6**). Select the machine to copy from. In this case "Fan 1" was selected. This action will copy the machine parts from Fan 1 to Fan 2 (→ **fig. 7**).
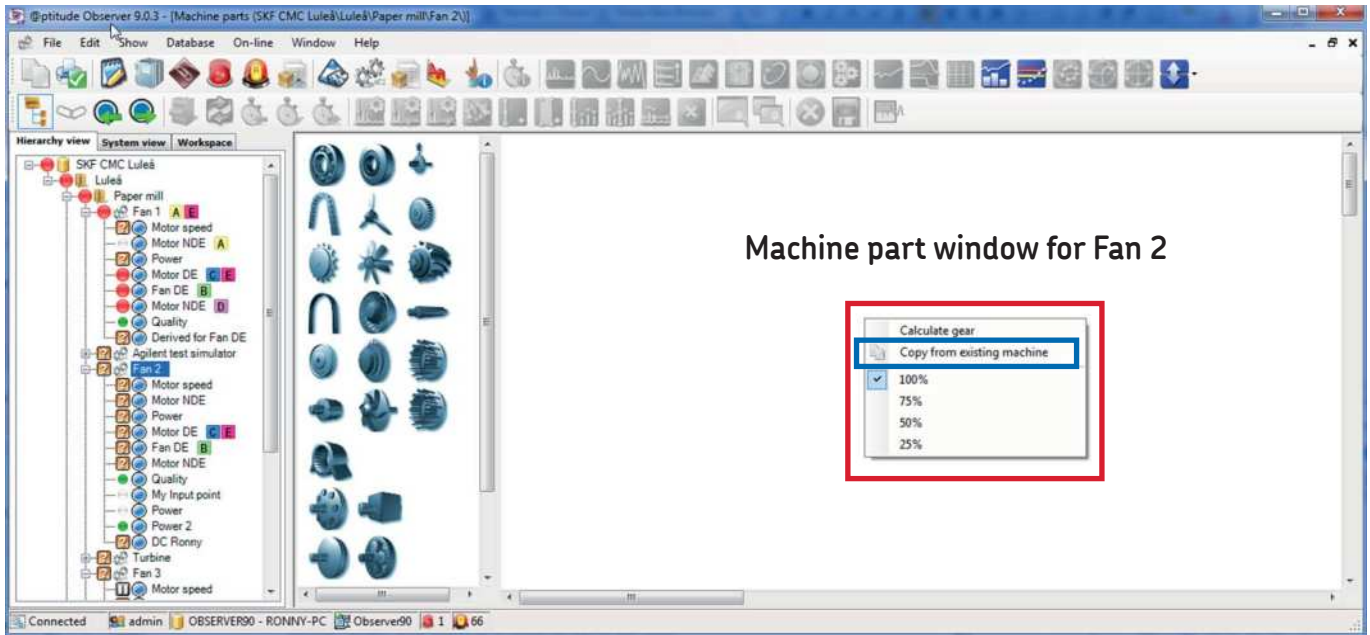

Fig. 5. Create machine parts for Fan 2 by copying from the existing machine Fan 1.
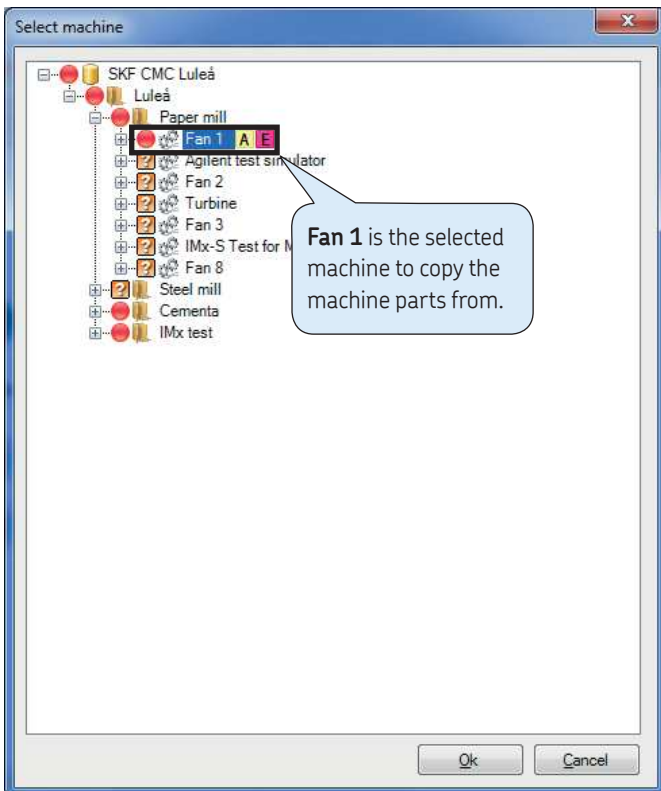

Fig. 6. Select a machine to "copy the machine parts from". "Fan 1" is selected.
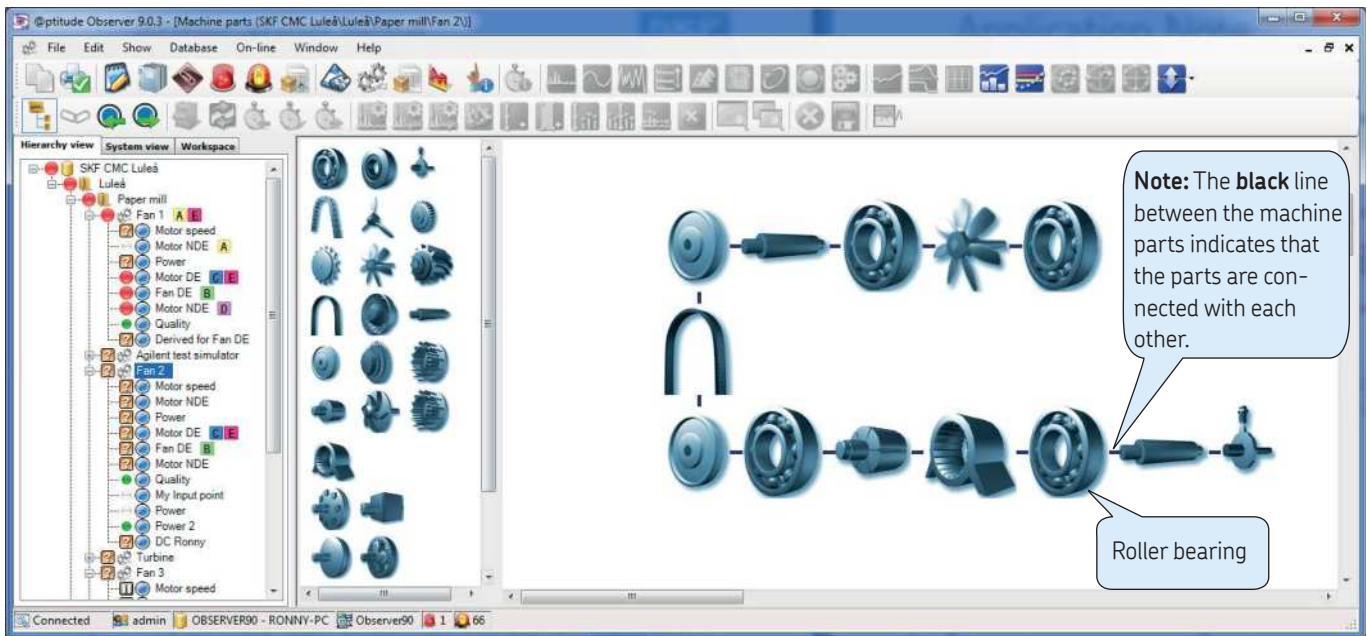
Fig. 7. The machine parts for Fan 2 are copied from Fan 1.

Right-clicking on a machine part in the working area provides the following options:

- **Calculate gear:** Calculates the gear ratio of the selected machine part. This is also done automatically when closing the machine parts window.
- **Delete:** Deletes the selected machine part.
- **Bring to front/back:** Brings the selected machine part to the front/back of the others, when machine parts are staggered on top of each other.
- **Properties:** Brings up the properties of the selected machine part and lets you configure the machine parameters for that specific machine part.

Right-clicking on the working area provides the following options:

- **Calculate gear:** Calculates the gear ratio of the selected machine part. This is done automatically when closing the machine parts window.
- **Copy machine parts from another machine:** Will automatically delete the machine parts on the existing machine.
- **The selected scales when zooming in the machine parts window are:** 100% (Full scale), 75%, 50%, 25%.

Each time a machine component is added, like the roller bearing in **fig. 7**, a **Machine parameters** window will open for data input. The **Machine parameters** windows depend on the selected component type. Here a bearing parameter window is shown (→ **fig. 8**).
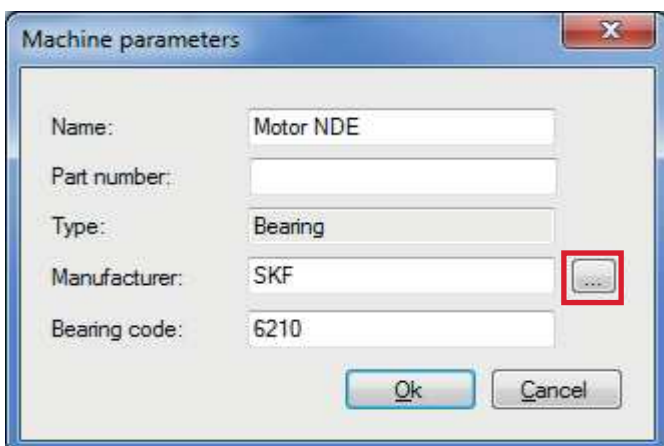

Fig. 8. The Machine parameters window for adding a roller bearing.

To add a roller bearing to the **Machine parameters** window in **fig. 8**, click the button with the three "dots". This opens the **Bearing library** in **fig. 9**. Select the "Manufacturer" of the bearing and then type the bearing code in the "Search bearing" field. In this case, the bearing code "6210" by SKF was selected. The bearing data, along with the fault frequencies, are displayed in the "Bearing data" box in **fig. 9** like:

- Bearing code
- Manufacturer
- Type of bearing – in this case a "Deep groove ball" bearing – and the bearing (fault frequencies/per rev.) for the:
    - Outer race (BPFO)
    - Inner race (BPFI)
    - Ball Spin Frequency (BSF)
    - Cage frequency (FTF = Fundamental Train Frequency)

In this case, a rotational speed of 1 rpm was selected, resulting in: 4.09 pulses/rev. for the BPFO (outer race) and so on (→ **fig. 9**).
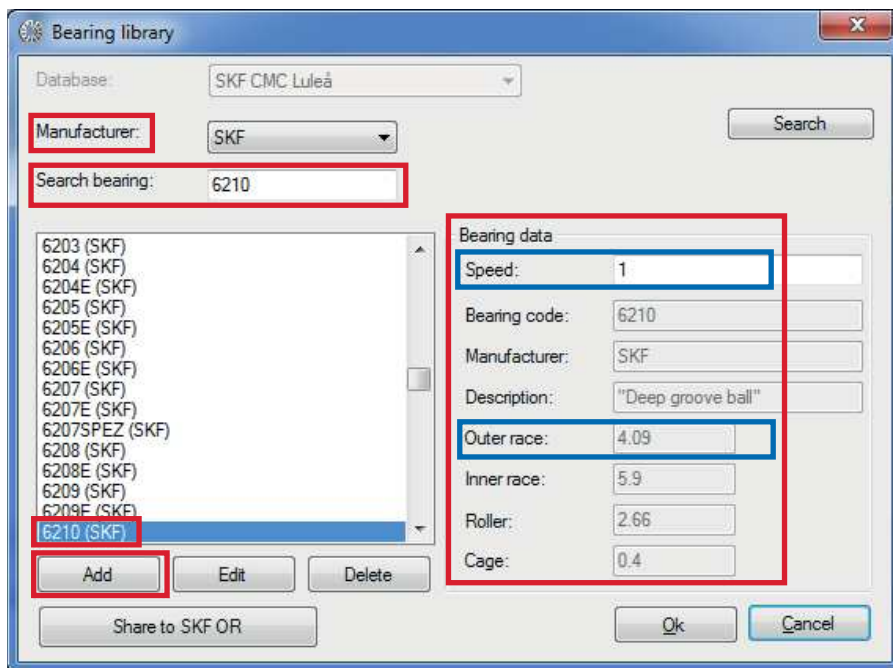

Fig. 9. Adding a rolling element bearing to the Bearing Library to the machine.

The bearing library stores data from approximately 20 000 bearings from SKF and a number of other vendors, and it is used for automatic calculation of the bearing defect frequencies. See **fig. 10** for available bearing manufacturers in the bearing library. The bearing library allows editing of the bearings in the database, and to find the bearing fault frequencies for the listed bearing.

When building machine parts, the system only allows for the selection of bearings available in this database. However, user defined bearings are added to the system by clicking the **Add** button in **fig. 9**. The **Bearing library** window in **fig. 11** opens. A "User defined" bearing is added to the database by knowing the geometrical data for the bearing like:

- Bearing pitch diameter
- Roller diameter
- Number of rollers
- Contact angle

The fault frequencies for a new bearing are calculated by clicking the **Bearing Calculator** button in **fig. 11**. As an example, the bearing calculator has calculated the fault frequencies for the recently added bearing (COOPER 34123). The "Dimensions" section in **fig. 12** displays the geometrical input data for the calculation.
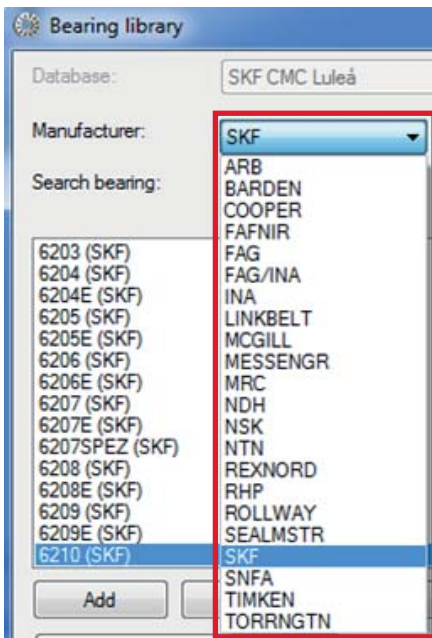
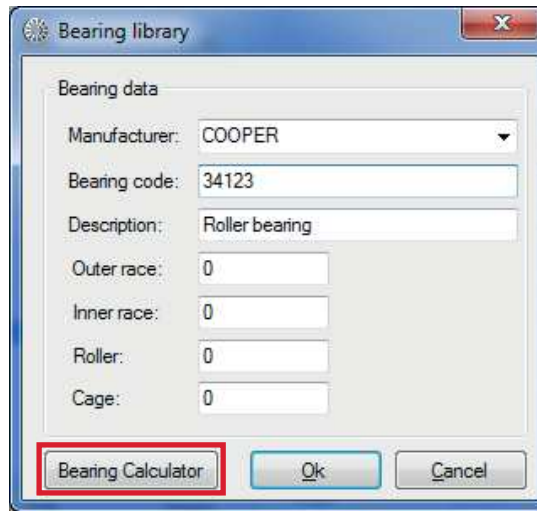Fig. 10. Available manufacturer in the bearing library.

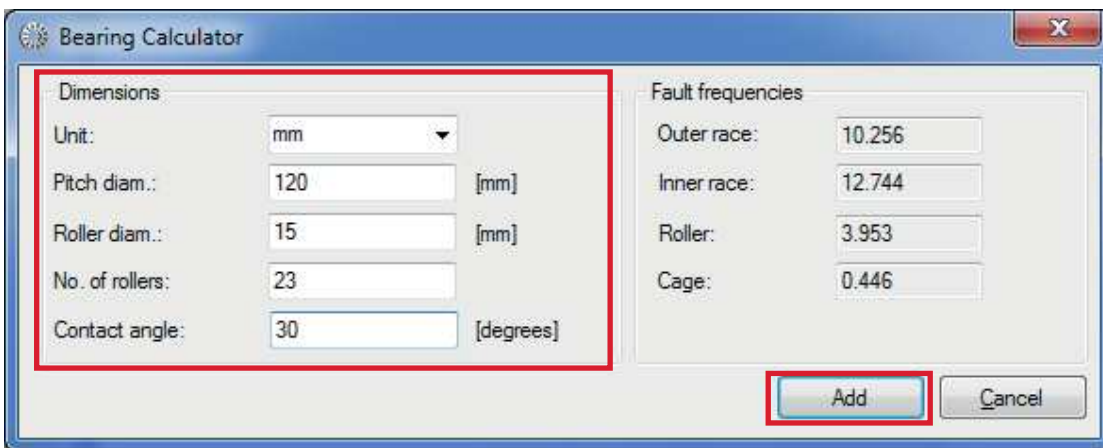Fig. 11. Adding a new bearing to the bearing database.

Fig. 12. The bearing calculator displaying the bearing dimensions and the calculated fault frequencies for the bearing "COOPER 34123".

Click the **Add** button in **fig. 12** to transfer the calculated fault frequencies to the **Bearing library** window in **fig. 13**. When clicking the **OK** button in **fig. 13**, you will get a question: "Do you wish to share this update to the SKF Online Repository?". If you select **No** in **fig. 14**, you can always change your mind at a later point in time and share your recently added bearing with other SKF @ptitude Observer users around the world.
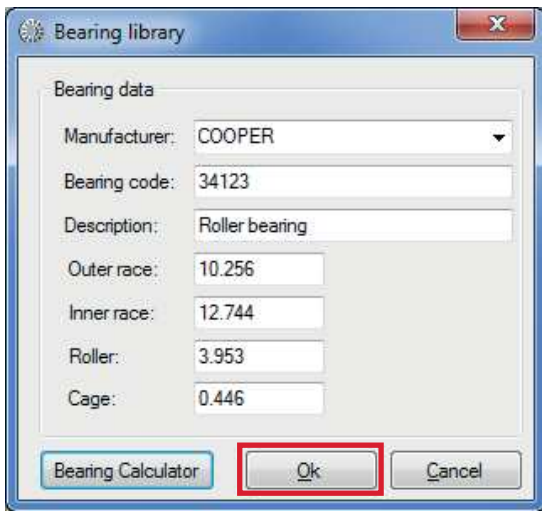
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Fig. 13. The calculated fault frequencies for the new bearing "COOPER 34123".
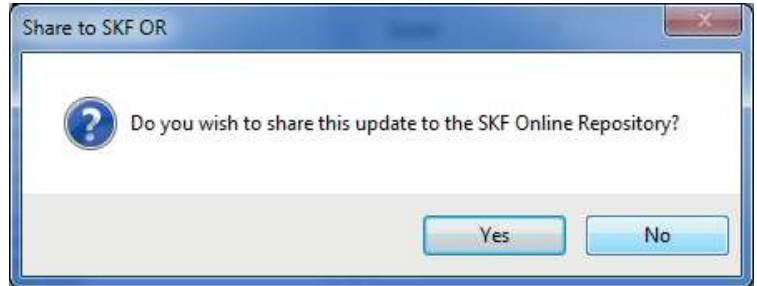
Fig. 14. Do you wish to share the recently added bearing to the SKF Online Repository.

By clicking the **Share to SKF OR** button in **fig. 15**, your recently added bearing to the bearing database is shared with other SKF @ptitude Observer users around the world. After the submission approval by SKF, other users will automatically receive a notification the next time they start up their SKF @ptitude Observer system that a new bearing is available, and they can choose to automatically install the bearing in the bearing database.

Through the SKF Online Repository (SKF OR), it is possible to share with other SKF @ptitude Observer users:

- Roller bearing data
- Machine templates
- Data miner views
- Custom diagnosis rules

For more information, also see the yellow information box in fig. 16.
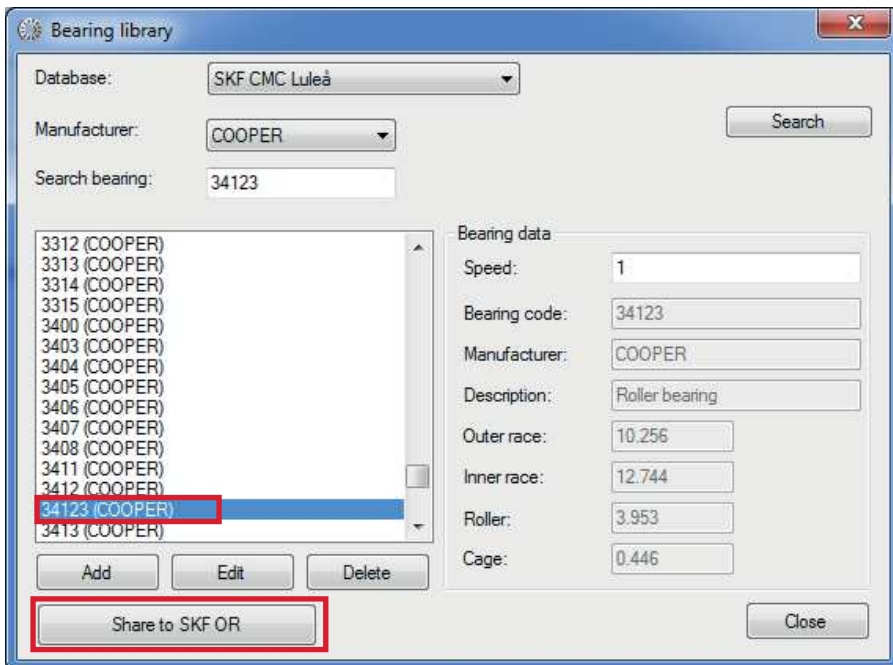

Fig. 15. Sharing the COOPER 34123 bearing with other SKF @ptitude Observer users by clicking "Share to SKF OR". The data to right side in the picture shows the four characteristic fault frequencies for the bearing.
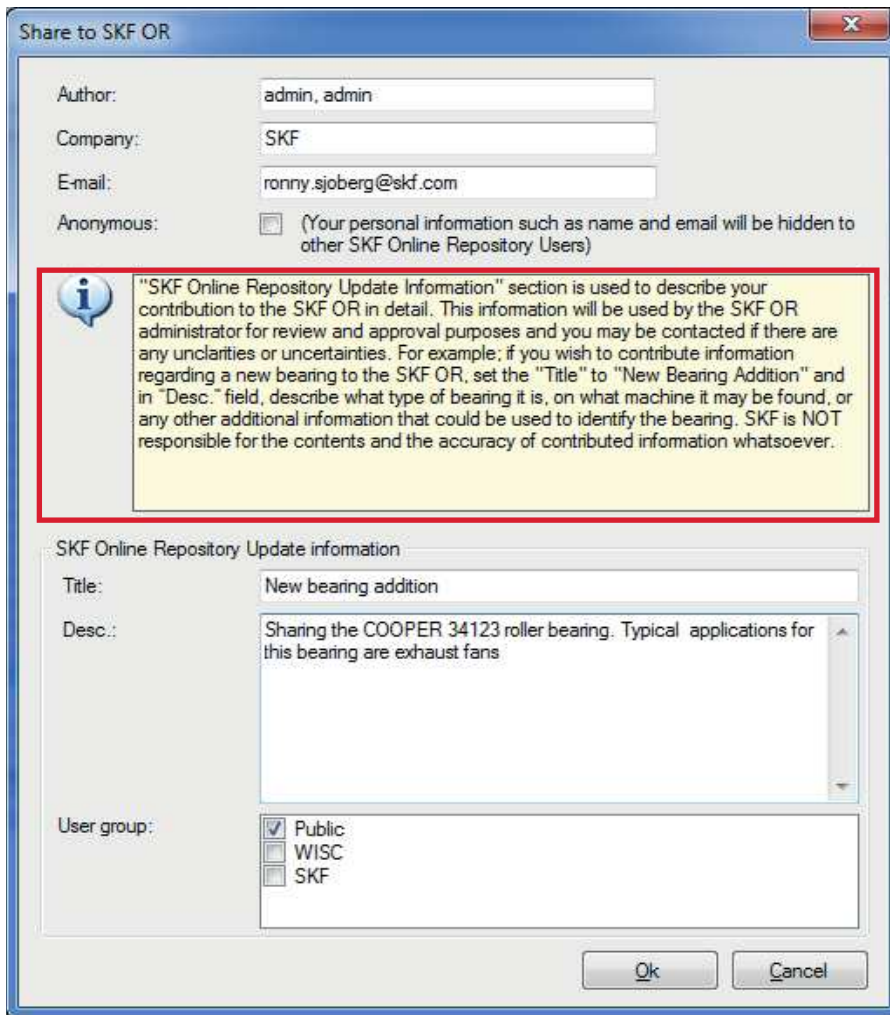
Fig. 16. Sharing my recently added bearing to the bearing database, with other SKF @ptitude Observer users around the globe. Pretty cool, isn't it?

Information about the SKF Online Repository (SKF OR)

From 2013 all SKF @ptitude Observer 9.X users have free access to the SKF Online Repository within their SKF @ptitude Observer software. For the future, all new licences will automatically get access to the SKF Online Repository upon creation of the licence key code. As an SKF @ptitude Observer user, it is possible for you to:

- **Take part in the SKF Online Repository** – Configures the system to be able to send and receive data from the SKF OR (if checked), see "Sections" in **fig. 17**.
- **Receive automatic notifications when new updates are available** – Enables the system to automatically check the SKF OR if there are any new updates available when the SKF @ptitude Observer system starts, see "Sections" in **fig. 17**. **Fig. 18** shows available updates to download. Check the updates that you would like to install in **fig. 18** and click the **Install** button.

Through the SKF Online Repository, it is also possible to share application logic and system design with other SKF @ptitude Observer users. Currently, it is possible to share:

- Bearing data
- Machine templates
- Data miner views
- Customized diagnosis rules

When adding a new bearing to SKF @ptitude Observer, this information can be shared with other SKF @ptitude Observer users. After the submission approval by SKF, the SKF @ptitude Observer users will receive a notification the next time they start the SKF @ptitude Observer system that a new bearing is available. The user can automatically choose to install the bearing in the SKF @ptitude Observer database or not. The same logic applies to:

- Machine templates (see application note **CM3196**)
- Data miner views
- Standard and private diagnosis rules (see application notes **CM3203** and **CM3218**)

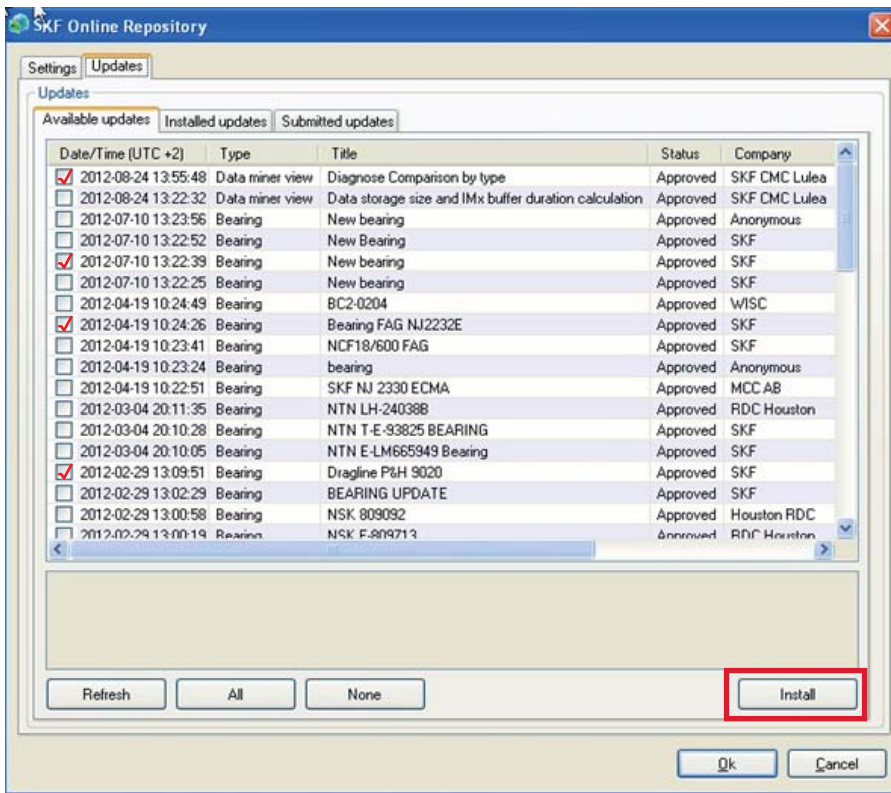*Fig. 17. SKF @ptitude Observer Online Repository main window.*

Fig. 18. An example of available updates to download from the SKF OR.

- **Available updates** are updates that are available for the user, but have not been downloaded and installed yet.
- **Installed updates** are updates that the user installed through the SKF OR.
- **Submitted updates** are updates that have been submitted, but not yet approved.

The data miner interface is a statistical producing tool that allows for complex data mining from the SKF @ptitude Observer database, which can be shown in three different formats:

- Tables
- Trends
- Bars

This interface allows comparing of measurement points, machines or even specific diagnosis between machines. Expert users can design their own statistical views, and if approved, the statistical views can be shared with other SKF @ptitude Observer users around the world through SKF Online Repository.

In order to create your own statistical views, you need to have a very good understanding of the SKF @ptitude Observer database structure. The SKF Remote Diagnostic Centres (RDC's) have a lot of analysis knowledge of wind turbines. The RDC's contribute with their knowledge in creating new diagnosis rules that can be used by all SKF @ptitude Observer users (**→ fig. 19**).
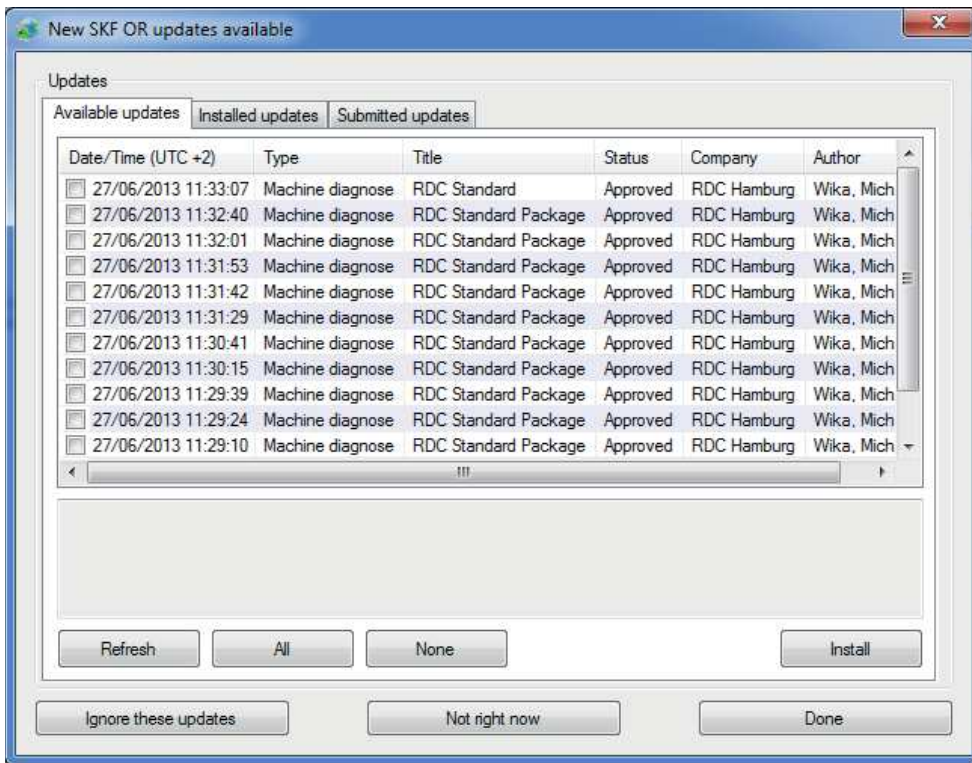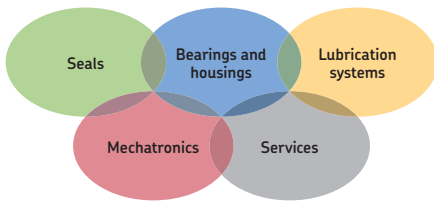
Fig. 19. New machine diagnosis rules uploaded to the SKF OR by the Remote Diagnostic Center in Hamburg, Germany.

The Power of Knowledge Engineering

Combining products, people, and application-specific knowledge, SKF delivers innovative solutions to equipment manufacturers and production facilities in every major industry worldwide. Having expertise in multiple competence areas supports SKF Life Cycle Management, a proven approach to improving equipment reliability, optimizing operational and energy efficiency and reducing total cost of ownership.

These competence areas include bearings and units, seals, lubrication systems, mechatronics, and a wide range of services, from 3-D computer modelling to cloud-based condition monitoring and asset management services.

SKF's global footprint provides SKF customers with uniform quality standards and worldwide product availability. Our local presence provides direct access to the experience, knowledge and ingenuity of SKF people.